

UDC 666.651:666.32

PROPERTIES OF A COMPOSITE CERAMIC AS A FUNCTION OF THE CLAY INITIAL MATERIAL RATIO

P. V. Nartsissova,¹ E. P. Golovin,¹ and R. M. Zakalyukin¹

Translated from *Steklo i Keramika*, No. 8, pp. 21–22, August, 2008.

A composition for obtaining a composite material, possessing an anorthite crystal phase, for fabricating the adjustment parts of low-voltage apparatus has been developed. The effect of replacing a portion of the kaolin with clay on the operating characteristics of the material is investigated. It is shown that the strength of the material can be increased by increasing the clay content of the charge.

Producers of electric insulation parts are now replacing pastes which are used to manufacture low-voltage insulators with pastes which are used for high-voltage insulators. This is due to be quite low strength of low-voltage paste ($\sigma_b \approx 30$ MPa), which is inadequate for modern apparatus (for high-voltage paste the bending strength ≈ 240 MPa). However, this replacement has resulted in a large increase in the cost of insulators — the raw materials costs are higher and the firing temperature is higher. In addition, for high mechanical strength there are difficulties in using rejected parts — during grinding the material is contaminated with tool iron.

Consequently, switching the production of ceramic and, specifically, electrotechnical articles to regional sources of raw materials is a topical problem. The Vladimir region is a large center for the glass industry, and it has its own deposits of dolomite materials and its own base of supply of diverse forms of high-quality raw materials, which can be used to synthesize ceramics.

It is known that an anorthite crystal phase can be obtained from a mixture of kaolinite and chalk, but a mixture of pure oxides — SiO_2 , Al_2O_3 with CaO , where anorthite forms via a series of intermediate reactions with ghelenite and wollastonite precipitating, has been studied in greatest detail [1].

Kaolin with ratio $\text{SiO}_2 : \text{Al}_2\text{O}_3$ is close to anorthite, which suggests a higher yield of anorthite.

Our investigations have shown that the use of clay makes it possible to decrease (to the maximum degree) the production cost of the finished product, since using only kaolin to

introduce silicon and aluminum oxides into electroinsulating ceramic is not cost-effective [2].

The objective of our work was to investigate the possibility of using a mixture kaolin + clay and to determine the effect of the kaolin : clay ratio on the technological parameters of synthesis and the performance indicators of the ceramic.

Compositions into which Al_2O_3 was introduced by means of kaolin and clay in definite ratios were investigated. Compositions with kaolin : clay ratios 1 : 3 and 1 : 1 possess the best characteristics, and these compositions were used for subsequent investigations. The physical – mechanical properties of a composite ceramic obtained based on these compositions are presented in Fig. 1.

It is known that the strength of ceramic materials depends on the amount of the glass phase — the higher this amount, the lower the strength. For an initial composition, as the firing temperature increases, sections where a glass phase melts out are observed on the surface, and the linear dimensions of the samples change in the process.

As one can see in Fig. 1a, the strength of a composition with kaolin : clay ratio 1 : 3 increases sharply for firing temperatures in the range 1300–1350°C and reaches 90 MPa, which corresponds to high-frequency steatite ceramic (subgroup 200) and high-strength silicate porcelain, which are used to manufacture high-voltage dielectrics (GOST 20419–83). In addition, water absorption decreases and the shrinkage increases most linearly (see Fig. 1b and c).

X-ray phase analysis was used to study the phase composition of the synthesized materials. The phases were identified according to the ATK database. Diffraction peaks belonging to anorthite and ghelenite were found in the x-ray diffraction pattern (Fig. 2).

¹ Vladimir State University, Vladimir, Russia; Moscow University of Fine Chemical Technology, Moscow, Russia.

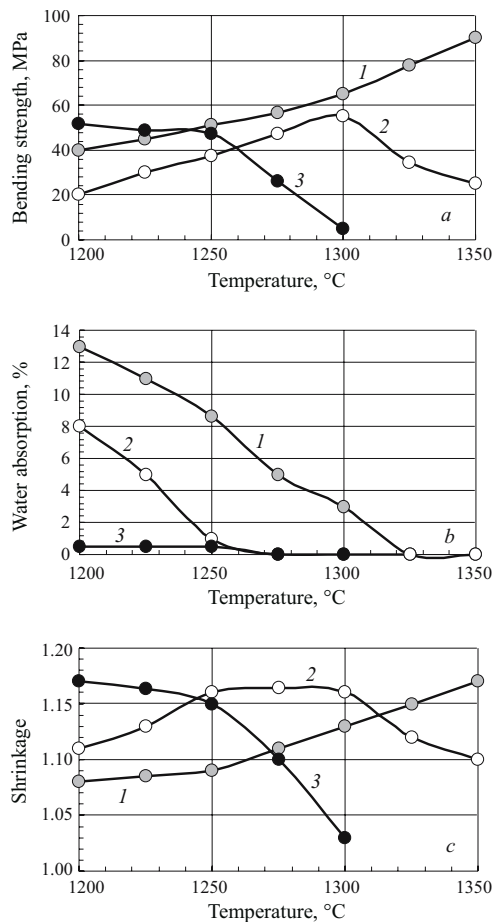


Fig. 1. Bending strength (a), water absorption (b), and shrinkage (c) as a function of firing temperature: kaolin – clay – chalk system with kaolin : clay ratios 1 : 3 (1) and 1 : 1 (2) and the initial composition (3).

When anorthite is synthesized, a substantial amount of low-viscosity, easily crystallizing, glass phase is formed. This results in a decrease of the temperature range of firing

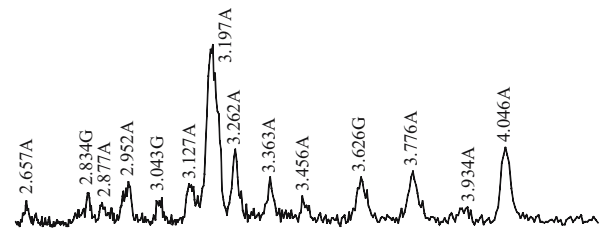


Fig. 2. Diffraction pattern of synthesized material (firing temperature 1260°C): A) anorthite, G) ghemelite.

and deformation of the parts. When the clay content of the initial charge is increased, a high-viscosity glass phase forms.

Analysis of the properties of the synthesized ceramic shows that it can be recommended for manufacturing the adjustment parts for low-voltage apparatus. Using more accessible raw materials and decreasing expenditures on the energy carrier makes it possible to decrease the production cost of parts and thereby maintain or even improve air quality.

The anorthite ceramic which has been developed possesses quite high physical – technical characteristics, at least as good as or exceeding the parameters of silicate porcelain. The apparent density of the anorthite ceramic is lower than that of porcelain, which will make it possible to decrease the mass of the parts without changing any of the other characteristics.

REFERENCES

1. P. P. Budnikov and A. M. Ginstling, *Reactions and Mixtures of Solid Materials* [in Russian], Gosstroizdat, Moscow (1965).
2. P. V. Nartsissova, E. P. Golovin, A. D. Savel'ev, and N. V. Fedorov, "Adjustment to ceramic based on raw material for glass production," in: *Designing and Technology of Eklectronics* [in Russian], Vladimir (2003), pp. 30 – 35.